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Diffusion and thermodynamic equilibrium under pressure variations

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Pressure is one of the most fundamental variables in mineral thermodynamics. In that respect, pressure-sensitive mineral reactions provide an important constraint on pressure under which the rock was developed. One implicit assumption when interpreting such pressure estimates is that the state-of-stress is close to hydrostatic, homogeneous and that the differential stress is negligible. Recent spectroscopic data from the mineral scale documenting pressure variations do not support this assumption. In addition to observations, mechanical models (numerical and analytical) suggest that rocks can develop and maintain heterogeneous pressure distributions at geological time scales. The recently developed unconventional barometry explains chemical zoning in minerals as a result of a pressure variation. We focus to apply the unconventional barometry in cases where chemical zoning in minerals cannot be explained by sluggish kinetics. In that respect, the unconventional barometry offers an alternative view of the chemical zoning which is consistent with thermodynamic equilibrium. However, to distinguish between a pressure-controlled chemical zoning and a zoning reflecting an incomplete chemical reaction is still challenging, especially for multicomponent systems.

In this contribution, different types of chemical zoning are discussed. We investigate plagioclase rims around kyanite from an amphibolitized eclogite from Rhodope Metamorphic Complex (Greece-Bulgaria) as a case study and compare them with similar published textures from the Bohemian Massif. Mineral microstructures and phase equilibrium suggest that both rocks experienced near-isothermal decompression at high (>700C) temperatures. However, several distinct microstructural features suggest the development and/or the decay of mechanically maintained heterogeneous pressure distributions. We discuss our results and interpretations based on phase-equilibrium modeling, unconventional barometry and diffusion modeling under pressure variations.